Origin Story

起源

万物大历史

A Big History of Everything

[美] 大卫·克里斯蒂安（David Christian）—— 著　孙岳 —— 译

中信出版集团

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> ——[illegible]·[illegible]Lia Hills[illegible] [illegible]“Return to the Heart”[illegible]

[illegible]1989[illegible]“[illegible]”[illegible]Atlantic College[illegible]

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[illegible]1986[illegible]·[illegible]William McNeill[illegible]“[illegible]”[illegible]“[illegible]”[illegible] [1] [illegible]H. G. Wells[illegible]

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[illegible]*Outline of History* [illegible]

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[illegible]anomie[illegible]20[illegible]

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[illegible]1989[illegible]1991[illegible]“[illegible]”[illegible]big history[illegible][4][illegible]Big History Project[illegible]

[illegible]21[illegible]

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[4] [illegible]“[illegible]”[illegible]“The Case for ‘Big History,’ ”*Journal of World History* 2, no. 2 (Fall 1991): 223–38[illegible]

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——[illegible]·[illegible]Joseph Campbell[illegible] [illegible]*The Hero with a Thousand Faces*[illegible]

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——[illegible]·[illegible]James Joyce[illegible]
[illegible]*Finnegans Wake*[illegible]

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[illegible]4[illegible]Willandra Lakes Region[illegible]Lake Mungo[illegible]Paakantji[illegible]Ngyiampaa[illegible]Mutthi Mutthi[illegible]4.5[illegible]

1992[illegible]1968[illegible]1[illegible] [1] [illegible]500[illegible]3[illegible]50[illegible]200[illegible]2017[illegible]9[illegible]Mungo Man[illegible]

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[illegible]·[illegible]Émile Durkheim[illegible]

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[illegible]“[illegible]”[illegible]·[illegible]“[illegible]”[illegible] [3]

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[illegible]·[illegible]Walter Alvarez[illegible]1 000[illegible]1 000[illegible]10 000 000 000 000 000 000 000[illegible]10^{22}[illegible] [4] [illegible]2016[illegible]

[illegible]·[illegible]Blaise Pascal[illegible]“[illegible]” [5] [illegible]

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[illegible]Goldilocks conditions[illegible][6] [illegible]

[illegible]thresholds[illegible]“[illegible]”[illegible]entropy[illegible]

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[6] [illegible]Goldilocks principle[illegible]Spier, *Big History,* 63–68[illegible]

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[illegible] 13.8 [illegible] 138 [illegible]

[illegible] 50 [illegible]

事　件	近似绝对时间	除以十亿后的时间
节点一："大爆炸"：宇宙开端	138 亿年前	13 年零 8 个月前
节点二：最初恒星开始闪耀	132（？）亿年前	13 年零 2 个月前
节点三：恒星死亡生成新元素	从节点二持续至今	从节点二持续至今
节点四：太阳及太阳系形成	45 亿年前	4 年零 6 个月前
节点五：地球上出现生命	38 亿年前	3 年零 9 个月前
地球上出现大型生物	6 亿年前	7 个月前
小行星撞击致使恐龙灭绝	6 500 万年前	24 天前
人类脱离黑猩猩谱系	700 万年前	2.5 天前
直立人问世	200 万年前	17 小时前

事　件	近似绝对时间	除以十亿后的时间
节点六：智人问世	20 万年前	100 分钟前
节点七：最后一次冰期结束，开启全新世，出现最早的农业	1 万年前	5 分钟前
出现最早的城市、国家和农业文明	5 000 年前	2.5 分钟前
罗马及汉帝国兴盛	2 000 年前	1 分钟前
世界多个区域连成一片	500 年前	15 秒前
节点八：化石燃料革命兴起	200 年前	6 秒前
发展大提速：人类登陆月球	50 年前	1.5 秒前
节点九：可持续世界秩序？	未来 100 年？	还有 3 秒
太阳死寂	未来 45 亿年后	还有 4 年零 6 个月
宇宙消失于黑暗之中，熵获胜	未来数兆年后	还有几十亿甚至上百亿年

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[illegible]energy[illegible]potential[illegible]·[illegible]“[illegible]” [5]

[illegible]·[illegible]Stephen Hawking[illegible] [6]

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·Fred Hoyle 1949

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·Georges Lemaître “ ” cosmic egg

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[illegible]

[illegible]potential for something to happen[illegible]“[illegible]”[illegible]inflation[illegible]

[illegible]absolute zero[illegible]2.76℃[illegible]

[illegible]phase changes[illegible]

[illegible]10^{-36} [illegible]clumpy[illegible]——[illegible]——[illegible]

[illegible]20[illegible]90[illegible]antigravity[illegible]70%[illegible]

[illegible]dark energy[illegible]placeholder[illegible]

[illegible]1905[illegible]·[illegible]E[illegible]m[illegible]c[illegible]$E=mc^2$[illegible]10[illegible]LHC[illegible]

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[illegible]·[illegible]Erwin Schrödinger[illegible]“[illegible]” [11]

[illegible]·[illegible]“[illegible]……[illegible]”[12]

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[illegible]Peter the Great[illegible]

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[illegible]operating rules[illegible]17[illegible]laws of physics[illegible]

[illegible]minimum[illegible]“[illegible]

[illegible]10^{36}[illegible]”[illegible]

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[illegible]——[illegible]·[illegible]Peter Hoffmann[illegible]“[illegible]” [13]

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[illegible]dark matter[illegible]plasma[illegible]photon[illegible]

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redshift

1814 · · Joseph von Fraunhofer spectroscope · Gustav Kirchhoff · Robert Bunsen absorption lines

20 · Vesto Slipher · Edwin Hubble parallax Proxima Centauri 4 19 ·

20 · Henrietta Leavitt Cepheid variable luminosity absolute brightness apparent brightness

[illegible]astronomical standard candles[illegible]·[illegible]

20[illegible]the Milky Way[illegible]1923[illegible]——[illegible]——[illegible]Andromeda nebula[illegible]

[illegible]1929[illegible]·[illegible]primordial atom[illegible]

[illegible]cosmological constant[illegible]

[illegible]20[illegible]1948[illegible]·[illegible]Hermann Bondi[illegible]·[illegible]Thomas Gold[illegible]·[illegible]

[illegible]20[illegible]40[illegible]·[illegible]Walter Baade[illegible]100[illegible]138.2[illegible]138.2[illegible]138[illegible]

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20[illegible]40[illegible]“[illegible]”[illegible]

[illegible]20[illegible]40[illegible]·[illegible]George Gamow[illegible]“[illegible]”[illegible]·[illegible]Ralph Alpher[illegible]

1964[illegible]·[illegible]Arno Penzias[illegible]·[illegible]Robert Wilson[illegible]3.5℃[illegible]·[illegible]Robert Dicke[illegible]

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[14] □□□□□□□□□□□□□□□□Krauss, *A Universe from Nothing* □

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——[illegible]·[illegible]Harlow Shapley[illegible]
[illegible]*View from a Distant Star*[illegible]

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[illegible]controlled,nonrandom flows of energy[illegible]structured flows of energy[illegible]

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[illegible]2015[illegible]9[illegible]Laser Interferometer Gravitational-Wave Observatory[illegible]LIGO[illegible]2017[illegible]4 000[illegible]LIGO[illegible]300[illegible]

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[illegible]complexity tax[illegible]·[illegible]Eric Chaisson[illegible]100[illegible][2]

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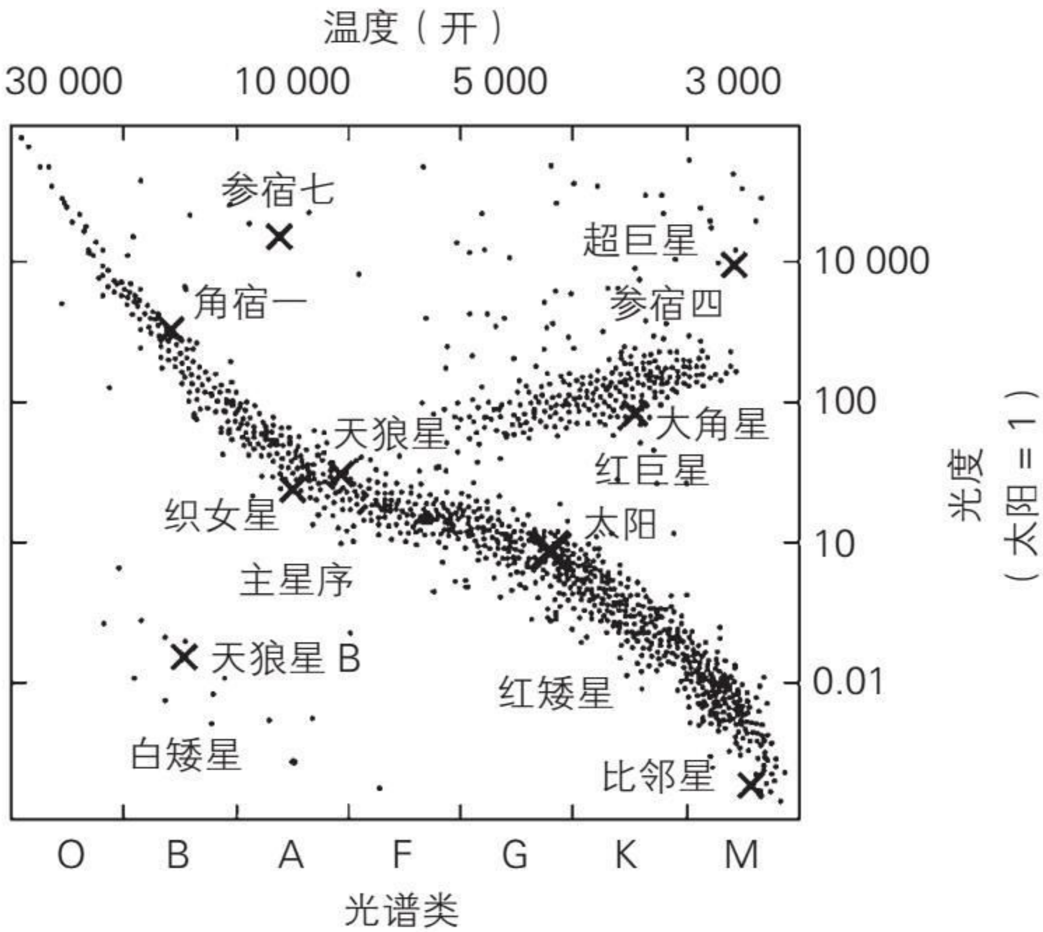
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[illegible]Hertzsprung-Russell diagram[illegible]

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[illegible]optical telescope[illegible]spectroscope[illegible]

[illegible]2 500K[illegible]30 000K[illegible]apparent brightness[illegible]

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[1] “[illegible]……[illegible]”[illegible]Peter Atkins, Four Laws That Drive the Universe(Oxford: Oxford University Press, 2007), 32[illegible]

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[5] King, *Stars* , 66[illegible]

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Ernest Rutherford

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[illegible]solar nebulae[illegible]99%[illegible]protoplanetary disks[illegible]

[illegible]chemical sorting[illegible]——[illegible]solar wind[illegible]——[illegible]——[illegible]80%[illegible]

[illegible]accretion[illegible]gassy planets[illegible]meteors[illegible]

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differentiation

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19[illegible]·[illegible]William Smith[illegible]19[illegible]Cambrian period[illegible]

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[illegible]1896[illegible]·[illegible]Henri Becquerel[illegible]20[illegible]·[illegible]isotope[illegible]238[illegible]92[illegible]146[illegible]half-life[illegible]45[illegible]235[illegible]92[illegible]143[illegible]7[illegible]

[illegible]geological clock[illegible]1904[illegible]5[illegible]1[illegible]

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1948[illegible]Zoser[illegible][5][illegible]14[illegible]14[illegible]5 730[illegible][6] 1953[illegible]·[illegible]Clair Patterson[illegible]45[illegible]

[illegible]bristlecone pines[illegible]DNA[illegible]genomes[illegible]——[illegible]——[illegible]

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[illegible]“[illegible]”[illegible]……[illegible]

——[illegible]·[illegible]Richard Dawkins[illegible] [illegible]*The Blind Watchmaker*[illegible]

[illegible]40[illegible]cell[illegible]*cella*[illegible]“[illegible]”[illegible]

[illegible]40[illegible]

[illegible]——[illegible]100[illegible]——[illegible]1[illegible]2[illegible]

[illegible]

[illegible]Vegemite sandwiches[illegible]2 500[illegible]1 050[illegible]4 184[illegible]86 400[illegible]120[illegible]120[illegible]“[illegible]”[illegible]power rating[illegible]120[illegible] [1]

[illegible]complex adaptive systems[illegible]agent[illegible] [2]

[illegible]“[illegible]”[illegible]·[illegible]Seth Lloyd[illegible]“[illegible]”[illegible] [3]

[illegible]“[illegible]” [4] [illegible]

[illegible]——[illegible]——[illegible]

[illegible]·[illegible]Daniel Dennett[illegible]“[illegible]……[illegible]informavores[illegible]”[5] [illegible]——[illegible]——[illegible]

[illegible]E.coli[illegible]5%[illegible][6] [illegible]

[illegible][7] [illegible]

[illegible]SETI[illegible]1960[illegible]40[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible]

[illegible]

[illegible]（cytoplasm）[illegible]——[illegible]（cell membrane）——[illegible]·[illegible]（Peter Hoffmann）[illegible]

[illegible]（mitochondria）[illegible]（microtubules and actin filaments）[illegible]（kinesin and dynein）[illegible]（lysosomes）[illegible]（Golgi apparatus）[illegible][8]

[illegible]“[illegible]”[illegible]“[illegible]”（change）[illegible]

[illegible]“[illegible]”（homeostasis）[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]（template）[illegible]（genome）[illegible] DNA [illegible] RNA [illegible] RNA [illegible] DNA [illegible]

[illegible]

[illegible]·[illegible]（Charles Darwin）[illegible]（natural selection）[illegible]“[illegible]”[illegible]（ratchet）[illegible]

[illegible]（variation）[illegible]《*The Origin of Species* 》[illegible]

> [illegible]……[illegible]——[illegible]——[illegible] [9]

[illegible]

[illegible]

[illegible][10][illegible]Emma[illegible]Galápagos Islands[illegible]finches[illegible]“[illegible]”[illegible]

[illegible]

[illegible][11]

[illegible]autocatalytic cycle[illegible]catalyze[illegible]“[illegible]”[illegible]·[illegible]“[illegible]”[illegible][12][illegible]

[illegible]

[illegible]“[illegible]”[illegible]habitable zone[illegible]

[illegible]

[illegible]Enceladus[illegible]2017[illegible] [13]

[illegible]0~100℃[illegible]

[illegible]98%[illegible]

[illegible] [14]

[illegible]100[illegible]nucleotide[illegible]carbohydrate[illegible]phospholipid[illegible]

1952[illegible]·[illegible]Stanley Miller[illegible]

[illegible]1969[illegible]Murchison meteorite[illegible]DNA[illegible]chemical bases[illegible]

[illegible]——[illegible]——[illegible]suboceanic vents[illegible]2000[illegible]alkaline vents[illegible]

[illegible]

[illegible]30[illegible]2012[illegible]Pilbara[illegible]34[illegible] [15] 2016[illegible]9[illegible]37[illegible]stromatolites[illegible] [16] [illegible]38[illegible]2017[illegible]42[illegible] [17]

[illegible]

[illegible]Luca[illegible]LUCA[illegible]“[illegible]”[illegible]prokaryotes[illegible]Eubacteria[illegible]Archaea[illegible]Eukarya[illegible]

[illegible]

[illegible]virus[illegible]

Douglas Adams *The Restaurant at the End of the Universe* Hotblack Desiato

[18]

electrical gradient

Nick Lane

DNA [19]

RNA ATP

RNA DNA

·
Terrence Deacon autocatalytic reactions
[20]

ADP generator
molecules
chemiosmosis 20 60

nano-rotors

[illegible]

[illegible]DNA[illegible]1953[illegible]·[illegible]Francis Crick[illegible]·[illegible]James Watson[illegible]·[illegible]Rosalind Franklin[illegible]DNA[illegible]DNA[illegible]

DNA[illegible]deoxyribonucleic acid[illegible]RNA[illegible]ribonucleic acid[illegible]DNA[illegible]RNA[illegible]base[illegible]A[illegible]C[illegible]G[illegible]T[illegible]RNA[illegible]U[illegible]DNA[illegible]RNA[illegible]As[illegible]Cs[illegible]Gs[illegible]Ts[illegible]RNA[illegible]Us[illegible]TTA[illegible]TAG[illegible]

DNA[illegible]RNA[illegible]A[illegible]T[illegible]RNA[illegible]U[illegible]C[illegible]G[illegible]DNA[illegible]RNA[illegible]ribosome[illegible]

[illegible]DNA[illegible]RNA[illegible]sugar-phosphate chains[illegible]C[illegible]G[illegible]A[illegible]T[illegible]RNA[illegible]U[illegible]DNA[illegible]DNA[illegible]RNA[illegible]RNA[illegible]

RNA[illegible]DNA[illegible]DNA[illegible]RNA[illegible]RNA[illegible]RNA[illegible]RNA[illegible]DNA[illegible]DNA[illegible]RNA[illegible]DNA[illegible]

[illegible]38[illegible]

[illegible]

[illegible]

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[20] □□□·□□□□□□□□□□autocell□□□□Grisogono, "(How) Did Information Emerge?"

[illegible]5[illegible]

[illegible]

> [illegible]Estha[illegible]Rahel[illegible]……[illegible]Chacko[illegible]……[illegible]46[illegible]46[illegible]……[illegible]11[illegible]
>
> ——[illegible]·[illegible]Arundhati Roy[illegible]*The God of Small Things*[illegible]

[illegible][1] “[illegible]”[illegible]biosphere[illegible]·[illegible]Eduard Suess[illegible]1831—1914[illegible]atmosphere[illegible]hydrosphere[illegible]lithosphere[illegible]·[illegible]Vladimir Vernadsky[illegible]1863—1945[illegible]20[illegible]70[illegible]·[illegible]James Lovelock[illegible]·[illegible]Lynn Margulis[illegible]Gaia[illegible]

[illegible]

[illegible]

[illegible]3 000[illegible]

[illegible]

[illegible]38[illegible]convection cycles[illegible]

[illegible]20[illegible]60[illegible]——[illegible]plate tectonics[illegible]

[illegible]500[illegible]

1885[illegible]·[illegible]2[illegible]supercontinent[illegible]30[illegible]·[illegible]Alfred Wegener[illegible]1915[illegible]——[illegible]“[illegible]”[illegible]——[illegible]*The Origin of Continents and Oceans*[illegible]continental drift[illegible]Pangaea[illegible]Pan-Gaia[illegible]“[illegible]”[illegible]

[illegible]16[illegible]1600[illegible]Ortelius[illegible]torn away[illegible] [2] [illegible]20[illegible]60[illegible]continental shelves[illegible]

[illegible]19[illegible]·[illegible]Alexander von Humboldt[illegible] [3] [illegible]

[illegible]“[illegible]”[illegible]1926[illegible]11[illegible]AAPG[illegible]

[illegible]·[illegible]Arthur Holmes[illegible]1928[illegible]20[illegible]

[illegible]sonar[illegible]“[illegible]”[illegible]·[illegible]Harry Hess[illegible]“[illegible]”[illegible]“[illegible]”[illegible]20[illegible]50[illegible]paleomagnetism[illegible]

[illegible]

[illegible]

[illegible]paleomagnetic bands[illegible]10[illegible]25[illegible]

[illegible]Proterozoic eon[illegible]Hadean eon[illegible]44[illegible] [4]

[illegible]

[illegible]divergent margins[illegible]·[illegible]convergent margins[illegible]granitic continental plates[illegible]5 000[illegible]subduction zone[illegible]

[illegible]transform margins[illegible]San Andreas Fault[illegible]

[illegible]1 500[illegible] [5] [illegible]

[illegible]

[illegible]·[illegible]Carl Sagan[illegible]30%[illegible]

[illegible]·[illegible]“[illegible]”[illegible]early faint sun paradox[illegible]

[illegible]

[illegible]0~100℃[illegible]20[illegible]70[illegible]·[illegible]·[illegible]thermostats[illegible]

[illegible]erosion[illegible]

[illegible]carbonic acid[illegible]carbonate rocks[illegible]

[illegible][6][illegible]40[illegible][7]

[illegible]

[illegible]“[illegible]”[illegible]Curiosity Rover[illegible] [8]

[illegible]

[illegible]

[illegible]Tyrannosaurus rex[illegible]amoeba[illegible]

[illegible]DNA[illegible]A[illegible]C[illegible]G[illegible]T[illegible]700[illegible]800[illegible]8[illegible]DNA[illegible]

[illegible]Archaea[illegible]Eubacteria[illegible]Eukarya[illegible]18[illegible]·[illegible]Carl Linnaeus[illegible]nested classes[illegible]species[illegible]genus[illegible]*Homo sapiens*[illegible]*Homo*[illegible]*Homo habilis*[illegible]*Homo erectus*[illegible]*Homo ergaster*[illegible]family[illegible]order[illegible]class[illegible]phylum[illegible]kingdom[illegible]domain[illegible]Hominidae[illegible]

[illegible]Primates[illegible]Mammalia[illegible]Chordata[illegible]vertebrates[illegible]Animalia[illegible]

[illegible]

[illegible] [9]

[illegible]40[illegible]40[illegible]

[illegible]

[illegible]7/8[illegible]6[illegible]

[illegible]10[illegible]DNA[illegible]

[illegible]DNA[illegible]microbiome[illegible]

[illegible]30[illegible]

[illegible]binding sites[illegible]4[illegible]50[illegible][10][illegible]“[illegible]/[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]6[illegible]20[illegible][11][illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]

[illegible]chemotrophs[illegible][12][illegible]heterotrophs[illegible]

[illegible]

[illegible]35[illegible]

[illegible] [13] [illegible]

[illegible]——[illegible]

[illegible]——[illegible]

[illegible] [14] [illegible]stromatolites[illegible]Shark Bay[illegible]35[illegible]5[illegible]——[illegible]——[illegible]

[illegible]cyanobacteria[illegible]H_2O+CO_2+[illegible]→CH_2O[illegible]$+O_2$[illegible]5%[illegible]

30 25 reduction 30 24 0.001% 1%

25 GOE “ ” [15] O3

· “ ” oxygen holocaust

—— ——

Makganyene glaciation 23.5 22.2

close shave

1% 2% 10

[illegible]

[illegible]20[illegible]10[illegible]10[illegible]——[illegible]eukaryotic cells[illegible]——[illegible]

[illegible]——[illegible]——[illegible]respiration[illegible] CH_2O [illegible]+O_2 →CO_2 +H_2O+[illegible]

[illegible]10[illegible][16] [illegible]rates of primary production[illegible]——[illegible]——[illegible]10~1000[illegible] [17]

[illegible]18[illegible] [18] [illegible]20[illegible]~10[illegible]“[illegible]”[illegible]the boring billion[illegible]

[illegible]10~100[illegible]*eukaryote*[illegible]“[illegible]”[illegible]“[illegible]”[illegible]DNA[illegible]

[illegible] [19] [illegible]paramecium[illegible]

[illegible]·[illegible]symbiosis[illegible]·[illegible]endosymbiosis[illegible]

[illegible]DNA[illegible]DNA[illegible]

[illegible]convergence[illegible]

[illegible]——[illegible]DNA[illegible]RNA[illegible]

[illegible]——[illegible]——[illegible]DNA[illegible]10[illegible]“[illegible]”[illegible]Phanerozoic eon[illegible]

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[illegible]6[illegible]

[illegible]

[illegible]

——[illegible]·[illegible]Andrew Knoll[illegible]
[illegible]*Life on a Young Planet*[illegible]

[illegible]

[illegible]35[illegible]——[illegible]metazoans[illegible]——[illegible]30[illegible]

[illegible]

[illegible]——[illegible]

[illegible]30[illegible]830[illegible]Burj Khalifa[illegible]

[illegible] 5 [illegible] 4 [illegible] 15% [illegible] 5% [illegible] niches [illegible]

[illegible]

[illegible] 10 [illegible]

[illegible] slime molds [illegible] *Dictyostelium* [illegible] slug [illegible] spores [illegible] multicellularity [illegible] [1] [illegible]

[illegible] apoptosis [illegible] 500 [illegible]

[illegible] 1998

[illegible]*Caenorhabditis elegans*[illegible]302[illegible]18 891[illegible]90%[illegible] [2]

[illegible]200[illegible]*Hox* genes[illegible] [3] [illegible]DNA[illegible]“[illegible]”[illegible]“[illegible]”[illegible]200[illegible]

[illegible]

[illegible]

[illegible]10[illegible]6[illegible]

[illegible]7[illegible]1990[illegible]the Cryogenian period[illegible]7.2[illegible]8 500[illegible]1000[illegible]—50℃[illegible]

[illegible] [4] [illegible]18[illegible] [5] 10[illegible]Rodinia[illegible]

[illegible]true polar wander events[illegible]30[illegible]30[illegible] [6]

[illegible]

[illegible]6.35[illegible]

[illegible]Ediacaran period[illegible]6.35[illegible]5.4[illegible]90%[illegible]

[illegible]

[illegible]20[illegible]40[illegible]100[illegible]100[illegible]5.4[illegible]4.9[illegible]Cambrian period[illegible]cnidarians[illegible]ctenophores[illegible]

[illegible]adaptive radiation[illegible]5.5[illegible]20[illegible]

[illegible]Phanerozoic eon[illegible]

[illegible]19[illegible]·[illegible]Adam Sedgwick[illegible]trilobites[illegible]arthropod[illegible]19[illegible]35[illegible]

[illegible]modularity[illegible]

[illegible]*phyla*[illegible]5.35[illegible]1000[illegible]6[illegible][7]

[illegible]chordata[illegible]vertebrates[illegible]lancelets[illegible]

[illegible]

[illegible]

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[illegible]·[illegible]Niles Eldredge[illegible]·[illegible]·[illegible]Stephen Jay Gould[illegible]1972[illegible]“[illegible]”[illegible]punctuated[illegible] [8] [illegible]

[illegible]specialized specie[illegible]——[illegible]koalas[illegible]——[illegible]

[illegible]25[illegible]

[illegible]Cambrian explosion[illegible]4.85[illegible]Burgess Shale[illegible] [9] [illegible]Ordovician period[illegible]4.5[illegible]60%[illegible]

[illegible]2.48[illegible]Permian period[illegible]80%[illegible]

[illegible]（Siberian Traps）[illegible]38℃[illegible]——[illegible]（methane clathrates）[illegible]——[illegible]（greenhouse mass extinction）[illegible][10] [illegible]

[illegible]

[illegible]

[illegible]30[illegible]（stomata）[illegible]

[illegible]（desiccation）[illegible]（capillary action）[illegible]

[illegible]4.5[illegible]（late Ordovician extinction）[illegible]

[illegible]4.3[illegible]（vascular plants）[illegible]4[illegible]

[illegible]lungfish[illegible]

[illegible]5%~10%[illegible]35%[illegible]3.7[illegible]17%~30%[illegible] [11] [illegible]17%[illegible]Permian period[illegible]3[illegible]2.5[illegible]

[illegible]

[illegible]3.7[illegible]Devonian period[illegible]3.75[illegible]1/10[illegible] [12] [illegible]lignin[illegible]Carboniferous period[illegible]3.6[illegible]3[illegible]90%[illegible]3.3[illegible]2.6[illegible]

[illegible] [13] [illegible]4000[illegible] [14]

[illegible]4.5[illegible]3[illegible]

[illegible]

[illegible]

[illegible] [15] [illegible]

[illegible] 50 [illegible] 90 [illegible] 20 [illegible] 3.2 [illegible] amniotes [illegible]

[illegible] Triassic period [illegible] 2.5 [illegible] 2 [illegible] 2 [illegible] bipedalism [illegible] Jurassic period [illegible] 2 [illegible] 1.5 [illegible] 1.6 [illegible] 6500 [illegible] Cretaceous period [illegible]

[illegible] Archaeopteryx [illegible] 1861 [illegible] 1.5 [illegible]

[illegible]2[illegible]2.5[illegible]6 500[illegible]rodent[illegible]

[illegible]·[illegible]

[illegible]

[illegible]“[illegible]”[illegible]

[illegible][16][illegible][17][illegible]

[illegible]limbic system[illegible]·[illegible][18]

[illegible]

[illegible]reason[illegible]

[illegible]——[illegible]——[illegible]consciousness[illegible] [19] [illegible]

[illegible]cleaner wrasse[illegible]

[illegible] [20]

[illegible]general systems[illegible]

[illegible]——[illegible]

[illegible] 6 500 [illegible]

[illegible] 10 [illegible] ~15 [illegible] [21] [illegible] K-T [illegible] K/T event [illegible] Cretaceous period [illegible] K [illegible] *Kreide* [illegible] “[illegible]” [illegible] Tertiary period [illegible] Cenozoic era [illegible] 6 500 [illegible]

[illegible] 30 [illegible] / [illegible] 10 [illegible] / [illegible] Yucatán Peninsula [illegible] Chicxulub [illegible] 200 [illegible] Hell Creek Formation [illegible] [22]

[illegible] nuclear winter [illegible]

[illegible]

[illegible] · [illegible] foraminifera [illegible] 1977 [illegible] iridium [illegible] 100 [illegible]

[illegible] 1990 [illegible]

[illegible]K-T[illegible]

[illegible]6 500[illegible]

[illegible]

[illegible]90%[illegible]DNA[illegible]30[illegible]base pairs[illegible]DNA[illegible]10%[illegible]

[illegible]marsupials[illegible]placentals[illegible]1.7[illegible]

[illegible]1.5[illegible][23][illegible]repenomamus[illegible]1.5[illegible]angiosperms[illegible]

[illegible]50[illegible]primate[illegible]

[illegible]——[illegible]（Paleocene-Eocene thermal maximum[illegible]PETM[illegible]5 600[illegible]——[illegible]——[illegible]5 600[illegible]5~9℃[illegible][24]

[illegible]5 800[illegible]5 600[illegible]

[illegible]20[illegible]

[illegible]（Milankovitch cycle[illegible]Gondwanaland[illegible]

[illegible]3 000[illegible]C4[illegible]C3[illegible][25]

[illegible]5 000[illegible]2 600[illegible]Pleistocene epoch[illegible]2.5[illegible]2.5[illegible]5 000[illegible]——[illegible]

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[illegible]7[illegible]

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——[illegible]·[illegible]Steven Pinker[illegible]*The Language Instinct*[illegible]

[illegible]

——[illegible]·H. [illegible]William H. McNeill[illegible]*Mythistory*[illegible]

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[illegible]

[illegible]chimps[illegible]gorillas[illegible]orangutans[illegible]

[illegible]lemurs[illegible]monkeys[illegible]great apes[illegible]

[illegible]neocortex[illegible]10%~40%[illegible]50%[illegible]80%[illegible][2][illegible]150[illegible]60[illegible][3][illegible]100[illegible]

[illegible]20[illegible]16%[illegible]2%[illegible]sea slugs[illegible]……[illegible][4][illegible]

[illegible]——[illegible]3[illegible]50[illegible]100[illegible]

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20[illegible]70[illegible]2 000[illegible]1968[illegible]——[illegible]·[illegible]Vincent Sarich[illegible]·[illegible]Allan Wilson[illegible]——[illegible]DNA[illegible]DNA[illegible]800[illegible]

[illegible]96%[illegible]30[illegible]3 500[illegible]70[illegible]

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[illegible]hominins[illegible]50[illegible]30[illegible]“[illegible]”[illegible]

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□*Ardipithecus* □□□□□□600□□□□*Orrorin tugenensis* □□□□□□

700[illegible]*Sahelanthropus tchadensis*[illegible]——[illegible]——[illegible]

[illegible]*Homo habilis*[illegible]

[illegible]knuckle-walk[illegible]3 000[illegible]

[illegible]300~450[illegible]1 350[illegible]encephalization quotient[illegible]EQ[illegible]2[illegible]5.8[illegible]2.4~3.1[illegible][8][illegible]

[illegible]*Homo*[illegible]250[illegible]150[illegible]1960[illegible]Olduvai Gorge[illegible]·[illegible]“[illegible]”[illegible]

[illegible]500~700[illegible]3[illegible]

[illegible]200[illegible]

[illegible]200[illegible] *Homo erectus* [illegible] *Homo ergaster* [illegible]

[illegible] [9] [illegible] social calculations [illegible] [10] [illegible] 50 [illegible] 200 [illegible] 50 [illegible]

[illegible] 1891 [illegible]·[illegible] African chimpanzees [illegible] Asian orangutans [illegible] 900 [illegible] 1 350 [illegible] 3~4 [illegible] *Homo floriensi* [illegible] Hobbits [illegible] 6 [illegible] Flores [illegible] [11]

[illegible] Acheulean axes [illegible]·[illegible] Richard Wrangham [illegible]

[illegible] 80 [illegible]

[illegible]40[illegible] [12] [illegible]100[illegible]
[illegible]

[illegible]100[illegible]60[illegible]150[illegible] [13]

[illegible]50[illegible]Schöningen[illegible]40[illegible]·[illegible]mussel shells[illegible]50[illegible]

[illegible]——[illegible]*Homo sapiens*[illegible]

[illegible]

[illegible]20[illegible]“[illegible]”[illegible]*Homo neanderthalensis*[illegible]“[illegible]”[illegible]*Homo heidelbergensis* [illegible]20[illegible]Omo Valley[illegible]2017[illegible]6[illegible]30[illegible]

[illegible]200[illegible]70[illegible]100[illegible]

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[illegible]——[illegible]——[illegible]1 800[illegible]40[illegible]

[illegible]

[illegible]

[illegible]butterfly effects[illegible]·[illegible]Edward Lorenz[illegible]

[illegible]cultivate[illegible]domesticate[illegible]cassava[illegible]

[illegible]·[illegible]noösphere[illegible]·[illegible]Michael Tomasello[illegible]“[illegible]……[illegible]”[illegible]“[illegible]”[illegible]cumulative cultural evolution[illegible][14]

[illegible]

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cultural ratchet

[16] collective learning

Noam Chomsky

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Eric Kandel

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shared learning ——

[illegible]transmission of culture[illegible]——[illegible] [20]

[illegible]·[illegible]“[illegible]”[illegible] [21]

[illegible]

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[illegible]20[illegible]30[illegible] [22] [illegible]

[illegible]competitive exclusion[illegible] [23] [illegible]——[illegible]——[illegible]

[illegible]10[illegible]20[illegible] [24] [illegible]——[illegible]——[illegible]7[illegible]Mount Toba[illegible]

[illegible]

[illegible]10[illegible]

[illegible]Blombos Cave[illegible]·[illegible]Christopher Henshilwood[illegible]9[illegible]6[illegible][25][illegible]bone points[illegible]

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[illegible]4[illegible]5[illegible]4[illegible]

2[illegible]Mezhirich[illegible]30[illegible]

[illegible]

[illegible]200[illegible]10[illegible]Holocene epoch[illegible]10[illegible]2[illegible]2.2[illegible]1.8[illegible]

[illegible]4[illegible] [26] [illegible]Lawn Hill River[illegible]

[illegible]

[illegible] [27] 10[illegible]Skhul[illegible]Qafzeh[illegible]6[illegible]5[illegible]6[illegible]Sahul[illegible]6[illegible] [28] [illegible]——[illegible]

[illegible]2[illegible]4[illegible]2[illegible]Beringia[illegible]

[illegible]1.5[illegible]

[illegible]·[illegible]Robin Dunbar[illegible]150[illegible]150[illegible]

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[illegible]Snowy River[illegible]bogong moths[illegible]corroborees[illegible]1.5[illegible]Lascaux Caves[illegible]La Madeleine[illegible]

[illegible] megafauna [illegible] *Genyornis newtoni* [illegible]

[illegible] dodo [illegible] moas [illegible]

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[illegible] scientific [illegible]

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[illegible]7[illegible]·[illegible]（Massimo Livi-Bacci）[illegible]3[illegible]50[illegible] [29]

[illegible]2[illegible]12[illegible]25[illegible]12[illegible]10[illegible]10[illegible]

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[illegible]·[illegible]（Marshall Sahlins）[illegible] [30] [illegible]

2[illegible]1.2[illegible]

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——·John Ball

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[illegible]honey ants[illegible]“[illegible]”[illegible]

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[illegible]teosinte[illegible]wild mouflon sheep[illegible]10[illegible]

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[illegible]

[illegible]500[illegible]3[illegible]world zones[illegible]

[illegible]Afro-Eurasia[illegible]6[illegible]1.5[illegible]the Solomons[illegible]4[illegible]3.5[illegible]

[illegible][2][illegible]1500[illegible]

[illegible]

[illegible]1.4[illegible]5 000[illegible]Fertile Crescent[illegible]2 000[illegible]4 000[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]2[illegible]1.3[illegible]Younger Dryas[illegible]1 000[illegible]1[illegible]10[illegible]6[illegible]1[illegible]

[illegible]“[illegible]”[illegible]Gardens of Eden[illegible]Dampier Archipelago[illegible]9 000[illegible][3][illegible]1.4[illegible]Natufians[illegible]“[illegible]”[illegible]affluent foragers[illegible]

[illegible]

[illegible][4]

honey trap [5]

Abu Hureyra 20 70 1.3 rye 1.1 [6]

S

[illegible] [7] [illegible]

[illegible]

[illegible] [8] [illegible] [9]

[illegible]（Australasia）[illegible]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible]1.1[illegible]5 000—4 000[illegible]

[illegible]

[illegible]

[illegible]8 000—4 000[illegible]swidden agriculture[illegible]4 000[illegible]3 000[illegible]5 000[illegible]3 000[illegible]

[illegible]100[illegible][10][illegible]5 000[illegible]

[illegible]

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[illegible]

[illegible]5 000[illegible]

[illegible]·[illegible]150[illegible]

[illegible]5 000[illegible]

[illegible]

[illegible]Göbekli Tepe[illegible]12 000—9 000[illegible][11][illegible]200[illegible]20[illegible]5[illegible]20[illegible]Stonehenge[illegible]Chaco Canyon[illegible]

[illegible] [12] [illegible]

[illegible] castes [illegible]

[illegible] “[illegible]” big men [illegible]

[illegible]

[illegible] ·[illegible] Andrew Sherratt [illegible] “[illegible]” secondary products revolution [illegible] pastoral nomads [illegible] “[illegible]” Silk Roads [illegible]

[illegible]Mesopotamia[illegible]——[illegible]

[illegible]10[illegible]500[illegible]5 000[illegible]40[illegible]

[illegible]·[illegible]the Four Horsemen[illegible]——[illegible]——[illegible]

[illegible]5 000[illegible]

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[illegible]9[illegible]

[illegible]

[illegible]Agade[illegible]

[illegible]

[illegible]

[illegible]……

[illegible]

[illegible]

[illegible]Inanna[illegible]

[illegible]

——[illegible]S. N. Kramer[illegible]

[illegible]5 000[illegible]

[illegible]

[illegible]

[illegible]

[illegible]（Kalahari Desert）[illegible]（mongongo nuts）[illegible][1][illegible]

[illegible]

[illegible]

[illegible]6 000[illegible]

[illegible]5 000[illegible]（Uruk）[illegible]100[illegible]（Standard Professions List）[illegible]

[illegible]

[illegible] 10 [illegible]

[illegible] 150~200 [illegible] Çatalhüyük [illegible] Varna [illegible] 6 000 [illegible] 200 [illegible] 10% [illegible] 1 000 [illegible] penis sheath [illegible] [2] [illegible] 10% [illegible]

[illegible]

[illegible] Melanesia [illegible]

[illegible] 2000 [illegible]

[illegible][3] [illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]

[illegible]

[illegible]

[illegible]（obsidian）——[illegible]（Jericho）[illegible]9 000[illegible]3 000[illegible]

[illegible]5 000[illegible]

[illegible]

[illegible]

[illegible]·[illegible]Thomas Hobbes[illegible]*Leviathan*[illegible]1651[illegible]“[illegible]……[illegible]”[illegible]·[illegible][4][illegible]

[illegible]Sumer[illegible]5 500[illegible]5 500[illegible]1[illegible]200[illegible]5[illegible]2.5[illegible][5][illegible]

[illegible]5[illegible]King Gilgamesh[illegible]*Gilgamesh*[illegible]“[illegible]Ishtar[illegible]”[illegible]

[illegible]5 000[illegible]Eanna[illegible]——[illegible]“[illegible]xxx[illegible]”“[illegible]xxx[illegible]”“[illegible]xxx[illegible]”“[illegible]xxx[illegible]”[illegible]

[illegible]Standard of Ur[illegible]5 000[illegible]

5 000

[illegible]

[illegible]*Arthasastra* [illegible]2 000[illegible]4 200[illegible]400[illegible]800[illegible]500[illegible]200[illegible]Magadha[illegible]Pataliputra[illegible]Patna[illegible]Rome[illegible]320[illegible]327[illegible]Mauryan[illegible]Kautilya[illegible]Candragupta Maurya[illegible]320—[illegible]298[illegible]

[illegible]“[illegible]——[illegible]”[6] [illegible]

[illegible]

> [illegible]……[illegible]*danda* [illegible][7]

[illegible]

[illegible]“[illegible]”[8] [illegible]

[illegible]“[illegible]”[illegible] [9]

[illegible]·[illegible]

> [illegible]……[illegible]……[illegible]……[illegible]……[illegible]Salus Populi[illegible]……[illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]Inca empire[illegible]*qipu*[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

5 000[illegible]1 000[illegible]4 000[illegible]1 000[illegible]1000[illegible]chiefdoms[illegible]2 000[illegible]

[illegible]·[illegible]Rein Taagepera[illegible]3000[illegible]1/10[illegible]megameter[illegible]2000—[illegible]1000[illegible]1 000[illegible]1%[illegible]

[illegible]4 000—3 000[illegible]1 000[illegible]2000—[illegible]1000[illegible]1000[illegible]Cyrus[illegible]560[illegible]Achaemenid Empire[illegible]Assyrian Empire[illegible]6[illegible]Mauryan Empire[illegible]3[illegible]2000[illegible]2 000[illegible]16[illegible]13%[illegible]

[illegible]

[illegible]Susa[illegible]Ephesus[illegible]Sardis[illegible]Darius[illegible]Herodotus[illegible]2 700[illegible]7[illegible]90[illegible]

[illegible]——[illegible]——[illegible]bronze[illegible]3 000[illegible]1000[illegible]Iron Age[illegible]

[illegible]shamans[illegible]·[illegible]Ahura Mazda[illegible]

[illegible]caravansaries[illegible]

[illegible]4 000[illegible]2 000[illegible]——[illegible]——[illegible]smallpox[illegible]bubonic plague[illegible]

2 000—1 000[illegible]1 500[illegible]Justinian I[illegible]

[illegible]2 000[illegible]Sassanian[illegible]Kushan[illegible]2 000—1 000[illegible]1 000[illegible]8[illegible]——[illegible]

4[illegible]13[illegible]2 000[illegible]3 000[illegible]Aztec[illegible]Inca[illegible]

[illegible]

[illegible]

[illegible]2[illegible]25[illegible]B[illegible]10 000—5 000[illegible]5 000—2 000[illegible]10[illegible]10 000—2 000[illegible]40[illegible]2 500[illegible]100[illegible]

[illegible]C[illegible]2 000[illegible]70[illegible]

[illegible]——[illegible]——[illegible]D[illegible]5 000[illegible]F[illegible]

[illegible]

[illegible]10%[illegible]E[illegible]·[illegible]Thomas Piketty[illegible]1900[illegible]1%[illegible]50%[illegible]10%[illegible]90%[illegible]90%[illegible]10%[illegible]“[illegible]40%[illegible]50%[illegible]” [10]

[illegible]10%[illegible]

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[illegible]10[illegible]

[illegible]

[illegible]……[illegible]

——[illegible]·[illegible]Adam Smith[illegible]*An Inquiry into the Nature and Causes of the Wealth of Nations*[illegible]

[illegible]——[illegible]

——[illegible]·[illegible]Matthew Boulton[illegible]·[illegible]

[illegible]Anthropocene[illegible]

[illegible]

[illegible]1400[illegible]500[illegible]5[illegible]100[illegible]Aotearoa[illegible]700[illegible]

[illegible]walrus tusks[illegible]kurrajong bark[illegible]“[illegible]”[illegible]“[illegible]”[illegible]*nowie*[illegible]1770[illegible]Captain Cook[illegible]·[illegible]Joseph Banks[illegible]Botany Bay[illegible]“[illegible]”[illegible][1][illegible]

[illegible]——[illegible]——[illegible]15[illegible]Tenochtitlan[illegible]Cuzco[illegible]

[illegible][2][illegible]

1400[illegible]1500[illegible]15[illegible]1433[illegible]

[illegible]15~16[illegible]Ottoman Empire[illegible]16[illegible]1517[illegible]Babur[illegible]Mughal Empire[illegible]

[illegible]1500[illegible]

1400[illegible]

1492[illegible]·[illegible]Christopher Columbus[illegible]

[illegible]2.5[illegible]·[illegible]Alfred Crosby[illegible]“[illegible]”[illegible]Columbian Exchange[illegible][3][illegible]*The Communist Manifesto*[illegible]

> [illegible]

[illegible]40[illegible]20[illegible]

[illegible]

[illegible]

[illegible]15[illegible]
[illegible]caravels[illegible]15[illegible]

[illegible]·[illegible]

1492[illegible]10[illegible]12[illegible]San Salvador[illegible]the Indies[illegible]Indians[illegible]“[illegible]”[illegible]——[illegible] [4] [illegible]1498[illegible]6[illegible]·[illegible]Vasco da Gama[illegible]

[illegible]——[illegible]——[illegible]·[illegible]Joseph Schumpeter[illegible]creative destruction[illegible]

[illegible]50[illegible]·[illegible]Hernán Cortés[illegible]·[illegible]Francisco Pizarro[illegible]

80%[illegible]

[illegible]——[illegible]——[illegible]Canary Islands[illegible]

16[illegible]40[illegible]Potosí[illegible]Acapulco[illegible]silver pesos[illegible]arbitrage trading[illegible]

[illegible]17[illegible]

[illegible]·[illegible]Johannes Gutenberg[illegible]15[illegible]1450—1500[illegible]1 300[illegible]1700—1750[illegible]3[illegible][5][illegible]

[illegible]16[illegible]·[illegible]Francis Bacon[illegible]“[illegible]”[6][illegible]·[illegible]Joseph Glanvill[illegible]1661[illegible]“[illegible]”[illegible][7]

[illegible]·[illegible]David Wootton[illegible]“[illegible]……[illegible]”[8] [illegible]“[illegible]”[illegible]17[illegible]1674[illegible]“[illegible]……[illegible]”[9] [illegible]18[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]·[illegible]werewolves[illegible]unicorns[illegible]*The Odyssey*[illegible][10] [illegible]Voltaire[illegible]——[illegible]——[illegible]

[illegible]·[illegible]

[illegible]——[illegible]·[illegible]——[illegible][11]

[illegible]capitalism[illegible]mobilization[illegible]

[illegible]——[illegible]——[illegible]

[illegible]·[illegible]·[illegible]

[illegible] [12]
16[illegible]Ivan the Terrible[illegible]19[illegible]entropy tax[illegible]

[illegible]guile[illegible]

[illegible]——[illegible]——[illegible]17[illegible]William III[illegible]1694[illegible]Bank of England[illegible]18[illegible]

[illegible]1500[illegible]

[illegible]

[illegible]

[illegible]12[illegible]18[illegible]1800[illegible]·[illegible][13][illegible]·[illegible]·[illegible]“[illegible]”[illegible][14]

[illegible]fossil-fuels revolution[illegible]3.6[illegible]·[illegible]Charles Dickens[illegible]·[illegible]Friedrich Engels[illegible]

[illegible]

17[illegible]1700[illegible]50%[illegible]1750[illegible]400[illegible]15%[illegible] [15] [illegible]

[illegible]17[illegible]18[illegible]Newcomen steam engines[illegible] [16] [illegible]

[illegible]·[illegible]1765[illegible]·[illegible]1769[illegible]1776[illegible]

[illegible]·[illegible]25[illegible]500[illegible]19[illegible]30[illegible]1850[illegible]9[illegible]20[illegible]·[illegible]200[illegible]150%[illegible]1.5[illegible] [17]

[illegible]

[illegible]19[illegible]GDP[illegible]1/5[illegible]19[illegible]1896[illegible]·[illegible]Svante Arrhenius[illegible]

[illegible]

[illegible]1800—1900[illegible]55[illegible]

[illegible]19[illegible]20[illegible]·[illegible]Michael Faraday[illegible]19[illegible]60[illegible]19[illegible]1837[illegible]19[illegible]

[illegible]1866[illegible]·[illegible]Alfred Nobel[illegible]Opium Wars[illegible]19[illegible]

[illegible]——[illegible]

[illegible] [18] 19[illegible]kerosene[illegible]——[illegible]——[illegible]rock salt[illegible]1857[illegible]·[illegible]Edwin Drake[illegible]Titusville[illegible]1859[illegible]8[illegible]27[illegible]15[illegible]75[illegible]“[illegible]50[illegible]……[illegible]……[illegible]“ [19] 1861[illegible]gusher[illegible]——[illegible]3 000[illegible]

[illegible]·[illegible]1880[illegible]

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[illegible]11[illegible]

[illegible]

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——[illegible]·[illegible]Paul Crutzen[illegible]2000[illegible]

[illegible]

——[illegible]·[illegible]Marshall McLuhan[illegible]

[illegible]20[illegible]“[illegible]”[illegible]era of humans[illegible]40[illegible]

[illegible]

[illegible]

[illegible]19[illegible]20[illegible]

[illegible]19[illegible]20[illegible]

[illegible]“[illegible]”（*Nemesis*）[illegible]17[illegible]1839—1842[illegible]

[illegible]——[illegible]——[illegible]（assegai）[illegible]

[illegible]“[illegible]”（the Enlightenment）[illegible]“[illegible]”[illegible]

[illegible]19[illegible]20[illegible]19[illegible]1914[illegible]30[illegible]

[illegible]1945[illegible]8[illegible]6[illegible]B-29“[illegible]”（Superfortress）[illegible]（Mariana Islands）[illegible]8[illegible]7[illegible]1945[illegible]8[illegible]9[illegible]

[illegible]20[illegible]21[illegible]1962[illegible]·[illegible]（John Kennedy）[illegible]“[illegible]”。[1]

“[illegible]”[illegible]40[illegible]（Great Acceleration）[illegible]

“” 40 3.4% 1914—1950 0.9% 1950 —1973 7.9% 1973—1998 5.1% [2] 1948 20 GATT 19 21 250

20

[illegible]

20 · Fritz Haber · Carl Bosch ——

19 19 20

[illegible]20[illegible]40[illegible]20[illegible]“[illegible]”[illegible]“[illegible]”[illegible]Manhattan Project[illegible]1945[illegible]“[illegible]”[illegible]10[illegible]1952[illegible]

[illegible]·[illegible]Albert Einstein[illegible]20[illegible]20[illegible]20[illegible]20[illegible]·[illegible]R. A. Fisher[illegible]

[illegible]1800[illegible]9[illegible]1900[illegible]15[illegible]1950[illegible]25[illegible]“[illegible]”[illegible]50[illegible]1800[illegible]200[illegible]60[illegible]200[illegible]60[illegible]

[illegible]70[illegible]1860[illegible]5[illegible]1960[illegible]20[illegible] [3] [illegible]1950—2000[illegible]1 900[illegible]9 400[illegible]

[illegible]sphere of mind[illegible]

[illegible]

[illegible]2000[illegible]19[illegible]

[illegible]1948[illegible]280[illegible]1972[illegible]3 670[illegible]25[illegible]19[illegible]20[illegible]10[illegible]

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19[illegible]

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20[illegible]19[illegible]GDP[illegible]15%[illegible]GDP[illegible]10%[illegible]20[illegible]20[illegible]21[illegible]OECD[illegible]1960[illegible]GDP[illegible]45%[illegible]30%~55%[illegible][4][illegible]

[illegible]20[illegible]political structures[illegible]UN[illegible]IMF[illegible]NGO[illegible]

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[illegible]20[illegible]18[illegible]

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[illegible]demographic transition[illegible]20[illegible]

[illegible]A380[illegible]“[illegible]”[illegible]

[illegible]

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[illegible]biogeochemical processes[illegible]biospheric thermostats[illegible]40[illegible]

[illegible]20[illegible]50[illegible]1958[illegible]·[illegible]Charles Keeling[illegible]megatons[illegible]40[illegible] [5] [illegible]ice cores[illegible]100[illegible]

[illegible]

20[illegible]“[illegible]” [6]

[illegible]1890[illegible]15[illegible]100[illegible]7[illegible]100[illegible]1990[illegible]118[illegible]89[illegible]

[illegible]1900[illegible]10[illegible]carbon biomass[illegible]13[illegible]——[illegible]——[illegible]35[illegible]21[illegible]2000[illegible]5[illegible]55[illegible]129[illegible]

[illegible]——[illegible]——[illegible]6 500[illegible]

[illegible]aquifers[illegible]10[illegible]24[illegible][7]

[illegible]rockthrowing catapults[illegible]

[illegible]

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[illegible]200[illegible]B[illegible]9[illegible]60[illegible]1 000[illegible]260[illegible]1 000[illegible]2 500[illegible]

[illegible]C[illegible]2 000[illegible]8 000[illegible]70[illegible]200[illegible]——1800—2000[illegible]——

[illegible]22[illegible]2 000[illegible]20[illegible]5 200[illegible]520[illegible]2 500[illegible]20 000[illegible]

[illegible]10%[illegible]

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[illegible]

[illegible]E[illegible]30[illegible]10[illegible]100[illegible]

[illegible]100[illegible]——[illegible]20[illegible]——[illegible]

[illegible]Good Anthropocene[illegible]

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[illegible]carbon monoxide[illegible]

[illegible]200[illegible]

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[6] □□□□□□□□□□□□·□□□□□□Wally Broecker□□□□□□David Christian, "Anthropocene Epoch," in *The Berkshire Encyclopedia of Sustainability,* Vol. 10: *The Future of Sustainability* , ed. Ray Anderson et al. (Barrington, MA:Berkshire Publishing, 2012), 22□

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[illegible]12[illegible]

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——[illegible]·[illegible]Yogi Berra[illegible]

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——[illegible]·[illegible]·[illegible]Charles Perkins Marsh[illegible]

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[illegible]“[illegible]”[illegible]

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[illegible]“[illegible]”[illegible]100[illegible]

[illegible]“[illegible]”[illegible]sense of closure[illegible]

[illegible]2 000[illegible] [1] [illegible]2 000[illegible]

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[illegible]100[illegible]

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[illegible]70[illegible]

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[illegible]——[illegible]——[illegible]

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[illegible]2015[illegible]2030[illegible]“[illegible]”[illegible]

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“[illegible]”[illegible]

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[illegible]15[illegible]17[illegible]169[illegible]

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[illegible]2015[illegible]12[illegible]12[illegible]195[illegible]2016[illegible]11[illegible]4[illegible]

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18·John Stuart Mill1848“” [3]

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1930·John Maynard Keynes“”*Economic Possibilities for Our Grandchildren*

[illegible]1968[illegible]3[illegible]·[illegible]Robert Kennedy[illegible]

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[illegible]

[illegible]——[illegible]——[illegible]（catastrophic explosion）——[illegible]——[illegible]——[illegible]（Human Revolution）[illegible]

[illegible]

[illegible]

[illegible]19[illegible]

[illegible]·[illegible]（Nikolai Kardashev）[illegible]

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trans-human global mind

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[illegible]
10^{100} [illegible]
[illegible]multiverse[illegible]

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[1] [illegible]·[illegible]·[illegible]Kim Stanley Robinson[illegible]*Red Mars* (1993), *Green Mars* (1994), *Blue Mars* (1996)[illegible]

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[illegible]·[illegible]Eric Chaisson[illegible]·[illegible]Johan Goudsblom[illegible]·[illegible]Walter Alvarez[illegible]·[illegible]Mojgan Behmand[illegible]·[illegible]Craig and Pamela Benjamin[illegible]·[illegible]Cynthia Brown[illegible]·[illegible]Leonid Grinin[illegible]·[illegible]Lowell Gustafson[illegible]·[illegible]Andrey Korotayev[illegible]·[illegible]Lucy Laffitte[illegible]·[illegible]Jonathan Markley[illegible]·[illegible]John Mears[illegible]·[illegible]Alessandro Montanari[illegible]·[illegible]Esther Quaedackers[illegible]·[illegible]Barry Rodrigue[illegible]·[illegible]Fred Spier[illegible]·[illegible]Joe Voros[illegible]·[illegible]·[illegible]2017[illegible]10[illegible]15[illegible]·[illegible]-[illegible]Felipe Fernández-Armesto[illegible]·[illegible]Bob Bain[illegible]·[illegible]Terry Burke[illegible]·[illegible]Ross Dunn[illegible]·[illegible]Pat Manning[illegible]·[illegible]——[illegible]Merry Wiesner-Hanks[illegible]·H.[illegible]William H. McNeill[illegible]·[illegible]Jerry Bentley[illegible]

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[illegible]·[illegible]Lawrence Krauss[illegible]·[illegible]Charles Lineweaver[illegible]·[illegible]Stuart Kauffman[illegible]·[illegible]Ann McGrath[illegible]·[illegible]Iain McCalman[illegible]·[illegible]Will Steffen[illegible]·[illegible]Jan Zalasiewicz[illegible]&[illegible]·[illegible]Tracy Behar[illegible]·[illegible]Charlie Conrad[illegible]·[illegible]Laura Stickney[illegible]·[illegible]Tracy Roe[illegible]·[illegible]John Brockman[illegible]

[illegible]·[illegible]·[illegible]·[illegible]Nick Doumanis[illegible]·[illegible]Connie Elwood[illegible]·[illegible]·[illegible]·[illegible]·[illegible]·[illegible]Ian Wilkinson[illegible]

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[illegible] [1]

年代	A：元年=公元前2000年	B：人口数（单位：百万）	C：消耗能量总量（单位：百万千兆焦耳/年）（=.001艾焦耳）（=B×D）	D：人均消耗能量（千兆焦耳/人均/年）（前三行=最大估计值）	E：预期寿命（年）（前三行=最大估计值）	F：最大定居点人口数（单位：千人）（第一行=最大估计值）
全新世	−10 000	5	15	3	20	1
	−8 000					3
	−6 000					5
	−5 000	20	60	3	20	45
	−2 000	200	1 000	5	25	1 000
	−1 000	300	3 000	10	30	1 000
人类世	−200	900	20 700	23	35	1 100
	−100	1 600	43 200	27	40	1 750
	0	6 100	457 500	75	67	27 000
	10	6 900	517 500	75	69	

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[1] A[illegible]E[illegible]Vaclav Smil, Harvesting the Biosphere, loc. 4528, Kindle[illegible]F[illegible]Ian Morris, Why the West Rules —— for Now, 148-149[illegible]10 000 BP[illegible]

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[illegible]absorption lines[illegible]spectroscope[illegible]

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[illegible]ATP[illegible]adenosine triphosphate[illegible]

[illegible]bacteria[illegible]Eubacteria[illegible]

[illegible]big bang cosmology[illegible]20[illegible]60[illegible]138.2[illegible]

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[illegible]capitalism[illegible]

[illegible]carbon[illegible]

[illegible]catalyst[illegible]

[illegible]Cepheid variable[illegible]

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[illegible]collective learning[illegible]

[illegible]complexity[illegible]

[illegible]（core）[illegible]

[illegible]（cosmic microwave background radiation，[illegible] CMBR）[illegible]38[illegible]

[illegible]（cosmology）[illegible]

[illegible]（crust）[illegible]

[illegible]（dark energy）[illegible]70%[illegible]

[illegible]（dark matter）[illegible]25%[illegible]

[illegible]（demographic transition）[illegible]

[illegible]（differentiation）[illegible]

[illegible]（DNA）[illegible]

[illegible]（domestication）[illegible]

[illegible]（Doppler effect）[illegible]

[illegible]（Earth）[illegible]

[illegible]（electromagnetism）[illegible]

[illegible]（electron）[illegible]

[illegible]（element）[illegible]92[illegible]

[illegible]（emergence）[illegible]

[illegible]emergent properties[illegible]

[illegible]energy[illegible]

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[illegible]Fertile Crescent[illegible]

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[illegible]first law of thermodynamics[illegible]

[illegible]foraging[illegible]

[illegible]fossil fuels[illegible]

[illegible]free energy[illegible]

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[illegible]Goldilocks conditions[illegible]“[illegible]”[illegible]

[illegible]gravity[illegible]

[illegible]greenhouse gases[illegible]

[illegible]Hadean eon[illegible]46[illegible]40[illegible]

[illegible]half-life[illegible]

[illegible]heat energy[illegible]

[illegible]helium[illegible]2[illegible]

[illegible]Hertzsprung-Russell diagram[illegible]

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[illegible]human[illegible]

[illegible]hydrogen[illegible]1[illegible]

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[illegible]（light-year）[illegible]9.5[illegible]

[illegible]（liquid）[illegible]

[illegible]（Luca）[illegible]

[illegible]（mantle）[illegible]3 000[illegible]

[illegible]（map）[illegible]

[illegible]（matter）[illegible]“[illegible]”（stuff）[illegible]

[illegible]（megafauna）[illegible]

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[illegible]（Milankovitch cycles）[illegible]

[illegible]（molecule）[illegible]

[illegible]（moon）[illegible]

multiverse

Natufians 14 500—11 500 “ ”

natural selection ·

neutron

nucleus

order, or structure

origin story

oxygen 8

Paleolithic period 20 1.1

Pangea 3 —2

paradigm · T. S. Kuhn

parallax

periodic table · Dmitry Mendeleyev Phanerozoic eon 5.4 “ ”

phase change

photon

photosynthesis

planet

plasma

[illegible]plate tectonics[illegible] [illegible]20[illegible]60[illegible]

[illegible]Pleistocene epoch[illegible] [illegible]260[illegible]—11 700[illegible]

[illegible]prokaryotes[illegible]

[illegible]Proterozoic eon[illegible] [illegible]25[illegible]—5.4[illegible]

[illegible]proton[illegible]

[illegible]quantum physics[illegible]

[illegible]quark[illegible]

[illegible]radioactivity[illegible]

[illegible]radiometric dating[illegible] [illegible]20[illegible]

[illegible]red giant[illegible]

[illegible]redshift[illegible]

[illegible]religion[illegible]

[illegible]respiration[illegible]

[illegible]RNA[illegible] [illegible]DNA[illegible]

[illegible]science[illegible] [illegible]17[illegible]

[illegible]second law of thermodynamics[illegible]

[illegible]sedentism[illegible]

[illegible]solar wind[illegible]

[illegible]solid[illegible]

[illegible]space-time[illegible]

[illegible]spectroscope[illegible]

[illegible]star[illegible]

[illegible]strong nuclear force[illegible]

[illegible]subatomic particles[illegible]

[illegible]sun[illegible]

[illegible]supernova[illegible]

[illegible]symbiosis[illegible]

[illegible]temperature[illegible]

[illegible]thermodynamics[illegible]“[illegible]”[illegible]

[illegible]thresholds of increasing complexity[illegible]

[illegible]trophic level[illegible]

1A[illegible]type 1a supernova[illegible]

[illegible]universe[illegible]

[illegible]weak nuclear force[illegible]

[illegible]white dwarf[illegible]

[illegible]work[illegible]

[illegible]world zones[illegible]1500[illegible]

[illegible]

[illegible]Outline of History [illegible]·[illegible]Cosmos [illegible]

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[illegible]

[illegible]2018[illegible]10[illegible]15[illegible]9[illegible]1[illegible]7[illegible]——[illegible]“[illegible]‘[illegible]’”[illegible]Is There Such a Thing as “Love” in Big History?[illegible]10[illegible]·[illegible]“[illegible]”[illegible]

[illegible]·[illegible]130[illegible]2017[illegible]

[illegible]13[illegible]Edge[illegible][1][illegible][2][illegible]

[illegible]“[illegible]”[illegible]·[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]——[illegible]——[illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]It therefore does not include automatically what we ought to do.[illegible]

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[illegible]“[illegible]”[illegible]

[illegible]MTI[illegible]

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2018[illegible]11[illegible]2[illegible]

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[1] [illegible]·[illegible]·[illegible]John Brockman, “A Conversation with David Christian,” Edge, May 21, 2015, http://edge.org/conversation/david_christian-we-need-amodern-origin-story-a-big-history

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